CLAIMS

[1] A method for treating exhaust gas comprising:

adsorbing target components in the exhaust gas with an adsorbent;

introducing a nitrogen gas with an oxygen concentration of 10 vol% or less and a purity of 90 vol% or more into the adsorbent; and

applying nonthermal plasma to the adsorbent,

wherein after the adsorbent adsorbs target components in the exhaust gas, the nitrogen gas is introduced into the adsorbent, and then an electric discharge is generated so that the nonthermal plasma of the nitrogen gas is applied to the adsorbent and causes desorption of the target components and regeneration of the adsorbent.

[2] The method according to claim 1, further comprising:

removing the target components desorbed by the nitrogen gas plasma in a nonthermal plasma reactor that follows or is integrated with the adsorbent.

[3] The method according to claim 1, wherein the adsorbent is zeolite with an average pore size of 0.1 to 5 nm.

[4] The method according to claim 1, wherein the exhaust gas is combustion exhaust gas, and the target components are at least one selected from the group consisting of NO, NO_2, N_2O, N_2O_5, SO_2, SO_3, volatile organic compounds (VOCs), pollutants as typified by dioxins, hydrocarbons, CO, CO_2, and water vapor (H_2O).

[5] The method according to claim 1, wherein the nitrogen gas with an oxygen concentration of 10 vol% or less and a purity of 90 vol% or more is part of exhaust gas emitted from a diesel engine.

[6] The method according to claim 1, wherein a gas temperature of the nitrogen gas plasma is 1000 K or less.

[7] The method according to claim 1, wherein the plasma is applied by using pulse discharge with an alternating or direct voltage, silent discharge,

corona discharge, surface discharge, barrier discharge, honeycomb discharge, pellet packed bed discharge, or any combination of these processes.

[8] The method according to claim 1, wherein the plasma is applied by using arc discharge with an alternating or direct voltage, inductively coupled discharge, capacitively coupled discharge, microwave excited discharge, laser induced discharge, electron-beam induced discharge, particle-beam induced discharge, or any combination of these processes.

[9] The method according to claim 1 or 3, wherein a catalyst is located in at least one of the following: inside of the adsorbent; inside of a plasma reactor; and downstream of the plasma reactor.

[10] An apparatus for treating exhaust gas comprising:

an adsorption portion for adsorbing target components in the exhaust gas with an adsorbent;

a gas flow path through which a nitrogen gas with an oxygen concentration of 10 vol% or less and a purity of 90 vol% or more is introduced into the adsorbent; and

a reactor for applying nonthermal plasma to the adsorbent,

wherein the adsorbent adsorbs target components in the exhaust gas, the nitrogen gas flows through the gas flow path in which the adsorbent is present, and an electric discharge is generated so that the nonthermal plasma of the nitrogen gas is applied to the adsorbent and causes desorption of the target components and regeneration of the adsorbent.

[11] The apparatus according to claim 10, wherein the apparatus is installed in a combustion system of any one of a diesel engine, a boiler, a gas turbine, and an incinerator.

[12] The apparatus according to claim 10, wherein a plurality of flow paths are arranged in a switchable manner, and the reactor for applying nonthermal plasma to the adsorbent and a plasma reactor for removing the target components are connected in series from a gas inlet toward an outlet in the flow paths.

[13] The apparatus according to claim 12, wherein the flow paths are switched by a valve or rotor.

[14] The apparatus according to claim 10, wherein flow paths through which the target components are desorbed and converted into harmless components become an exhaust gas recirculation system.

[15] The apparatus according to claim 10, further comprising an exhaust device that accelerates the adsorption and desorption by changing a gas pressure to more than or less than atmospheric pressure.

[16] The apparatus according to claim 10, further comprising a device that accelerates the adsorption and desorption by heating or cooling the exhaust gas or the nitrogen gas.

[17] The apparatus according to claim 10, further comprising a gas measuring device that includes a sensor for detecting an oxygen concentration in the exhaust gas.

[18] The apparatus according to claim 10, further comprising a particulate collector for collecting aerosol or particles in the exhaust gas.

[19] The apparatus according to claim 10, further comprising a humidity controller for controlling a humidity of the exhaust gas or the nitrogen gas.

[20] The apparatus according to claim 10, wherein the nitrogen gas with an oxygen concentration of 10 vol% or less and a purity of 90 vol% or more is part of exhaust gas emitted from a diesel engine.